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NATIONAL  
**GUIDELINE**  
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## General

### Guideline Title

AARC clinical practice guideline: transcutaneous monitoring of carbon dioxide and oxygen: 2012.

### Bibliographic Source(s)

Restrepo RD, Hirst KR, Wittnebel L, Wettstein R. AARC clinical practice guideline: transcutaneous monitoring of carbon dioxide and oxygen: 2012. *Respir Care*. 2012 Nov;57(11):1955-62. [114 references] [PubMed](#)

### Guideline Status

This is the current release of the guideline.

This guideline updates a previous version: American Association for Respiratory Care. Transcutaneous blood gas monitoring for neonatal & pediatric patients--2004 revision & update. *Respir Care* 2004 Sep;49(9):1069-72. [38 references]

## Recommendations

### Major Recommendations

The levels of evidence (A-D) and the strength of the recommendations (1-2) are defined at the end of the "Major Recommendations" field. The words "recommended" and "suggested" are used to reflect the strength of the recommendation, as level 1 and level 2, respectively.

#### Description/Definition

A transcutaneous (TC) monitor measures the skin-surface partial pressure of oxygen ( $P_{O_2}$ ) and partial pressure of carbon dioxide ( $P_{CO_2}$ ) to provide an estimate of the partial pressure of arterial oxygen ( $P_{aO_2}$ ) and partial pressure of arterial carbon dioxide ( $P_{aCO_2}$ ). The measurements obtained include partial pressure of transcutaneous oxygen ( $P_{tcO_2}$ ) and partial pressure of transcutaneous carbon dioxide ( $P_{tcCO_2}$ ). The TC monitor device induces hyperperfusion of the capillaries by increasing the local temperature of the skin at the sensor site. The externally applied heat alters the solubility of  $CO_2$  in the blood and increases the metabolic rate of the skin by approximately 4–5% for every degree Celsius, resulting in local production of  $CO_2$ . The sensor, usually a Severinghaus electrode, will calculate the  $P_{CO_2}$  electrochemically, usually by a change in pH of an electrolyte solution. Additionally, a temperature correction is used to address the epithelial  $CO_2$  produced by heating the skin. A Clark electrode, which is composed of a platinum cathode and silver anode, measures the  $P_{O_2}$ .

Each manufacturer's calibration protocol for the TC monitor sensor should be followed. After the sensor is calibrated, the skin must be cleaned of all oils, soaps, and dead skin. Once the site is cleaned, then a sensor fixation ring should be placed in a highly vascularized area. The preferred location to obtain TC measurements in neonates and small pediatric patients is the upper chest. Alternative sites may be the lateral side of the

abdomen, chest, buttock, inside of the upper thigh, forearm, the zygomatic bone, the ear lobe, cheeks, or the forehead. In order to achieve accurate  $P_{tcO_2}$  the skin probe temperature must be 44°C, which may lead to injury or burning of the skin, particularly in patients with thin or damaged skin. By contrast, monitoring of the  $P_{tcCO_2}$  is reliable with skin temperature even as low as 37°C. Most TC monitors allow the reduction of the probe temperature to minimize the risk of thermal injury. Correlation with arterial blood gases is recommended to ensure accuracy of the values obtained by TC monitor. When monitoring  $P_{tcCO_2}$  only, use of lower skin probe temperatures increases the systematic overriding of TC measurement and may allow for longer periods of contact time between the skin and the sensor, for up to 8–12 hours. This option may be especially important for neonatal population compliance with the minimal handling approach promoted in their care. However, changing sites as often as every 2 hours may be necessary in small premature neonates to avoid thermal injury.

After the fixation device is in place, 1–2 drops of either contact gel or normal saline should be placed inside the ring. This improves the accuracy of the sensor and makes the diffusion of gases more efficient. The sensor is then placed into the ring and usually snaps into place. The ring must create enough of a seal to prevent leaks or formation of air bubbles, as ambient air reaching the sensor affects measured values.

### Setting

Transcutaneous monitoring (TCM) may be performed by trained personnel in a variety of settings that include, but are not limited to hospitals, extended care facilities, and patient transport. It is utilized in the following specific clinical settings to determine the presence of hypoventilation or respiratory depression:

- Mechanical ventilation, including conventional modes of ventilation, high-frequency ventilation steady state high frequency jet ventilation, and noninvasive ventilation.
- Bronchoscopies or procedures requiring sedation or patient-controlled analgesia
  - Prolonged laparoscopic surgery procedures
- Sleep studies
  - $P_{tcO_2}$  may have an increased role in detecting sleep hypoventilation and assessing the efficacy of treatment of sleep disorders.
- Pulmonary function studies, including stress testing and bronchoprovocation
- Trending bicarbonate ( $HCO_3^-$ ) in diabetic ketoacidosis
- Apnea testing
- Transportation of a patient
- Evaluation of tissue perfusion
- Evaluation of postoperative hypercarbia
- Evaluation of hyperventilation during phonation of patients with vocal cord disorders
- Titration of long-term oxygen therapy

### Indications

The use of TCM is indicated in patients who either lack arterial access or have the need for continuous monitoring of oxygen and carbon dioxide with minimal blood draws. TCM allows the assessment of:

- Adequacy of oxygenation and/or ventilation
- Response to diagnostic and therapeutic interventions, as evidenced by  $P_{tcO_2}$  and/or  $P_{tcCO_2}$  values
  - Weaning and extubation decisions may be made based on  $P_{tcCO_2}$  measurement alone.
- TC oxygen index ( $P_{tcO_2}$ /Fraction of inspired oxygen ( $F_{IO_2}$ )), which can be used as an early marker of hypoperfusion and mortality
  - A ratio less than 200 should prompt evaluation and intervention.
- Tissue perfusion status and revascularization in wound care and peripheral arterial occlusive disease
  - $P_{tcO_2}$  is used in wound care and hyperbaric oxygen therapy as an effective tool to monitor critical limb ischemia.
    - A  $P_{tcO_2}$  on the affected limb should be maintained between 30–40 mm Hg to maintain adequate perfusion. A  $P_{tcO_2}$  less than 30 mm Hg may indicate poor perfusion to that limb, and a  $P_{tcO_2}$  less than 10 mm Hg is considered incompatible with spontaneous healing process.
    - $P_{tcO_2}$  is useful in the determination of optimal amputation level. A  $P_{tcO_2}$  of 30 mm Hg is considered the critical dividing value that separates successful from unsuccessful amputation stump healing.
- Monitoring response to therapy in patients with diabetic ketoacidosis, as  $P_{tcCO_2}$  correlates with serum  $HCO_3^-$  levels

### Contraindications

There are no documented absolute contraindications for use of TCM. In patients with poor skin integrity and/or adhesive allergy, alternative monitoring devices to TCM should be considered.

#### Hazards/Complications

$P_{tcO_2}$  and/or  $P_{tcCO_2}$  monitoring is considered a safe procedure. The most common hazards and complications of TCM are:

- Misinterpretation of falsely elevated or decreased levels of  $O_2$  and  $CO_2$  that may lead to inappropriate treatment of the patient.  $P_{tcO_2}$  underestimates  $P_{aO_2}$  and  $P_{tcCO_2}$  overestimates  $P_{aCO_2}$ . While some manufacturers have incorporated correction factors into the device software, what TCM really measures is skin  $P_{O_2}$  and  $P_{CO_2}$ , not  $P_{aO_2}$  and  $P_{aCO_2}$  per se.
- Thermal injury may occur at the sensor site (e.g., erythema, blisters, burns, skin tears).

#### Device Limitations/Validation of Results

$P_{tcO_2}$  is an indirect measurement of  $P_{aO_2}$  and does not reflect oxygen delivery or oxygen content. Complete assessment of oxygen delivery requires knowledge of hemoglobin saturation and cardiac output.  $P_{tcCO_2}$  is an indirect measurement of  $P_{aCO_2}$ , but knowledge of delivery and content is not necessary to use  $P_{tcCO_2}$  for assessment of ventilation.

Factors that may affect readings, limit precision, or limit the performance or application of a TC monitor include:

- Device related
  - Although some newer designs make application quicker and simpler, setup is labor intensive.
  - Prolonged stabilization time is required following electrode placement, typically up to 5–10 min, but varies by manufacturer.
  - While the theoretical basis for mandatory heating of the  $P_{tcO_2}$  electrode in newer TC monitors has not been established, manufacturers suggest heating the electrode to produce valid results.
    - Some clinical studies suggest that valid results may be obtained with  $P_{tcCO_2}$  electrodes operated at lower than recommended temperatures or with no heat.
  - Improper calibration, trapped air bubbles, leaks in the fixation device, and damaged membranes and their detection may result in misinterpretation of the values and erroneous changes in therapy.
    - If too much saline or contact gel is applied, a leak may be created between the skin and the fixation device.
- Clinical

The following clinical situations may result in falsely elevated or decreased  $P_{tcO_2}$  and  $P_{tcCO_2}$  values:

- Presence of hyperoxemia ( $P_{aO_2} > 100$  mm Hg) (elevated  $P_{tcO_2}$ )
- The presence of a hypoperfused state (shock, acidosis) and vasoactive drug administration may result in decreased  $P_{tcO_2}$  and  $P_{tcCO_2}$ . However, the use of newer TCM devices and placement of the sensor near the carotid artery have improved the correlation between  $P_{aO_2}$  and or  $P_{aCO_2}$  in this clinical situation.
- Improper electrode placement or application (elevated  $P_{tcO_2}$ ; decreased  $P_{tcCO_2}$ )
- Increased thickness or edema of the skin and/or subcutaneous tissue (decreased  $P_{tcO_2}$  and  $P_{tcCO_2}$ )
- Increased capillary blood flow induced by movement of the patient, either by self or due to routine care, may increase  $P_{tcO_2}$  and  $P_{tcCO_2}$ .
- Placement of the sensor site on the distal part of an extremity may result in lower readings, due to vasoconstriction limiting blood flow.
  - Some TC monitors allow for the use of the ear area (e.g., tragus) as a TC monitoring site. Studies have shown that the ear is an acceptable place for TC monitoring however, in some cases the ear is not an acceptable place, as it may interfere with a procedure (e.g., neurosurgery, maxillofacial surgery).
  - The ear sensor is less susceptible to detachment with patient movement and does not have to be removed for chest x-rays or other chest imaging procedures.
- Validation

Arterial blood gas values should be compared to TC readings taken at the time of arterial sampling, in order to validate the TC values. This validation should be performed initially and periodically, as dictated by the patient's clinical condition.

- During validation studies in patients with physiologic shunts, the electrode site and arterial sampling site should be on the same side of the shunt when measuring  $P_{tcO_2}$ . However, recent studies show that  $P_{tcCO_2}$  is not affected by shunts or ventilation-perfusion

mismatching, when compared to  $P_{aCO_2}$ .

- When a discrepancy exists between TC, measured arterial values, and the clinical presentation of the patient, possible causes should be explored before results are reported. Monitoring at alternative sites, recalibration, or equipment replacement may reduce discrepancies. If such steps do not remedy the disparity, TCM results should not be acted upon or recorded in the patient's medical record. Instead, a statement describing the TC use and the corrective action should be included in the patient's medical documentation, and some other mode of monitoring should be established (e.g., pulse oximetry, end-tidal  $CO_2$  [ $P_{ETCO_2}$ ] monitoring, arterial blood analysis). The absolute limits that constitute unacceptable discrepancies vary with patient condition and specific device. Clinical judgment must be exercised.
- When comparing or correlating values for  $P_{CO_2}$ , the  $P_{tcCO_2}$  value is typically higher than  $P_{aCO_2}$ . However, the  $P_{tcCO_2}$  is a good surrogate of the  $P_{aCO_2}$  and sometimes may provide a better estimate of  $P_{aCO_2}$  than  $P_{ETCO_2}$ . Reading an accurate  $P_{CO_2}$  value with a TC monitor requires more time than measuring  $P_{ETCO_2}$ , due to the required period of stabilization of the TCM.
  - Although the acceptable clinical range of agreement for  $P_{tcCO_2}$  is  $\pm 7.5$  mm Hg, the manufacturer's recommendations should be followed.

#### Assessment of Need

- When direct measurement of arterial blood is not available or accessible in a timely fashion,  $P_{tcO_2}$  and/or  $P_{tcCO_2}$  measurements may temporarily suffice if the limitations of the data are appreciated.
- TC blood gas monitoring is appropriate for continuous and prolonged monitoring (eg, during mechanical ventilation, continuous positive airway pressure [CPAP], and supplemental oxygen administration), but has limitations when used on an intermittent basis.
- $P_{tcO_2}$  values can be used for diagnostic purposes, as in the assessment of functional shunts (e.g., persistent pulmonary hypertension of the newborn) or persistent fetal circulation, or to determine the response to oxygen challenge in the assessment of congenital heart disease.

#### Assessment of Outcome

- Results should reflect the patient's clinical condition (i.e., validate the basis for ordering the monitoring).
- Documentation of results, therapeutic intervention, and/or clinical decisions based on the TC measurements should be noted in the patient's medical record.

#### Resources

- Equipment  
TC monitor, electrodes, calibration gases, and associated supplies. TC monitor should have been validated by the manufacturer, using appropriate quality control procedures and clinical reliability studies.

In order to help assure consistency of care based on TC blood gas readings, the operator should verify:

- High and low limit alarms are set appropriately
- Appropriate electrode temperature is set
- Electrode placement site is appropriate and systematic electrode site change occurs
- Specific manufacturer's recommendations for maintenance, operation, and safety are complied with
  - Some devices incorporate newer technologies to improve monitoring of oxygen and carbon dioxide by:
    - Allowing measurement of  $S_{pO_2}$ ,  $P_{tcO_2}$ , and  $P_{tcCO_2}$ , together or separately, through a miniaturized carbon dioxide tension  $P_{CO_2}/S_{pO_2}$  single sensor that monitors both  $P_{aCO_2}$  and oxygen saturation by pulse oximetry ( $S_{pO_2}$ )
    - Stabilizing TC values faster through the addition of a heat function
    - Showing the clinician, through a relative heating index, how much power the unit is using to warm the site
    - Maximizing measurement in low perfusion states through the incorporation of a compensatory heating probe
- Personnel  
Actively licensed and credentialed respiratory therapists or other credentialed healthcare providers with equivalent training and demonstrated ability to exercise the necessary clinical judgment, to assess the patient, and to perform the essential tasks of monitor calibration and application.

#### Monitoring

The monitoring schedule of patient and equipment during TCM should be integrated into the patient assessment and vital signs determinations. Results should be documented in the medical record and should detail the conditions under which the readings were obtained. Additional

documentation includes:

- The date and time of measurement, TC reading, patient's position, respiratory rate, and activity level
- Fraction of inspired oxygen ( $F_{IO_2}$ ) or supplemental oxygen flow, specifying the type of oxygen delivery device
- Ventilatory mode and settings
- Electrode placement site, electrode temperature, and time of placement
- Results of simultaneously obtained  $P_{aO_2}$ ,  $P_{aCO_2}$ , and pH when available
- Clinical appearance of the patient, subjective assessment of perfusion, pallor, and skin temperature

#### Frequency

TC blood gas monitoring should be continuous for development of trending data. Placement for intermittent and short duration measurements (i.e., spot checks) is not appropriate.

#### Infection Control

No special precautions are necessary, but standard precautions (as described by the Centers for Disease Control) are recommended.

- The device probe should be cleaned between patient applications, according to manufacturer recommendations.
- The external portion of the monitor should be cleaned by methods according to manufacturer recommendations in between patient use.

#### Recommendations

The following recommendations are made following the Grading of Recommendations Assessment, Development, and Evaluation (GRADE) criteria:

- Although  $P_{tcCO_2}$  has a good correlation with  $P_{aCO_2}$  and is a reliable method to evaluate plasma  $CO_2$  levels, it is recommended that arterial blood gas values be compared to TC readings taken at the time of arterial sampling, in order to verify the TC values, and periodically as dictated by the patient's clinical condition. (1A)
- It is suggested that  $P_{tcCO_2}$  may be used in clinical settings where monitoring the adequacy of ventilation is indicated. (2B)
- It is suggested that  $P_{tcO_2}$  and  $P_{tcCO_2}$  may be used in determining the adequacy of tissue perfusion and monitoring of reperfusion. (2B)
- It is suggested that TCM should be avoided in the presence of increased thickness or edema of the skin and/or subcutaneous tissue where the sensor is applied. (2B)
- It is recommended that sites used for a TCM be changed as often as necessary and that they be alternated and observed to avoid thermal injury. Manufacturer recommendations should be followed. (1C)

#### Definitions:

#### Grade of Quality of the Evidence

Grade	Quality	Description
A	High	Well-performed randomized controlled trials or overwhelming evidence of some other sort. Further research is very unlikely to change confidence in the estimate of the effect.
B	Moderate	Well-performed randomized controlled trials or overwhelming evidence of some other sort. Further research is very unlikely to change confidence in the estimate of the effect.
C	Low	Observational evidence (from observational studies, case series, or clinical experience), or evidence from controlled trials with serious flaws. Further research is very likely to have an important impact on confidence in the estimate of effect and is likely to change the estimate.
D	Very Low	Any estimate of effect is very uncertain.

#### Strength of the Recommendations

Level	Strength	Description
1	Stronger	Benefits clearly outweigh the risks and burdens (or vice versa) for nearly all patients.
2	Weaker	Risks and benefits are more closely balanced or are more uncertain.

Adapted from: Guyatt GH, Oxman AD, Vist GE, Kunz R, Falck-Ytter Y, Alonso-Coello P, Schünemann HJ; GRADE Working Group. GRADE: an emerging consensus on rating quality of evidence and strength of recommendations. *BMJ* 2008;336(7650):924-926.

## Clinical Algorithm(s)

None provided

## Scope

### Disease/Condition(s)

Any disease or condition requiring transcutaneous monitoring (TCM) of oxygen and carbon dioxide

### Guideline Category

Evaluation

Management

Risk Assessment

### Clinical Specialty

Critical Care

Emergency Medicine

Internal Medicine

Pediatrics

Pulmonary Medicine

### Intended Users

Advanced Practice Nurses

Nurses

Physicians

Respiratory Care Practitioners

### Guideline Objective(s)

To provide clinical practice guidelines on transcutaneous monitoring (TCM) of oxygen (P<sub>tcO<sub>2</sub></sub>) and carbon dioxide (P<sub>tcCO<sub>2</sub></sub>)

## Target Population

All patients requiring transcutaneous monitoring (TCM) of oxygen ( $P_{tcO_2}$ ) and carbon dioxide ( $P_{tcCO_2}$ ) values

## Interventions and Practices Considered

1. Assessment of need
2. Transcutaneous blood gas monitoring
3. Assessment of outcome
4. Resources required (equipment, personnel)
5. Monitoring of patient and equipment
6. Infection control

## Major Outcomes Considered

- The patient's clinical condition
- Documentation of results, therapeutic intervention, and/or clinical decisions based on the transcutaneous measurements

## Methodology

### Methods Used to Collect/Select the Evidence

Searches of Electronic Databases

### Description of Methods Used to Collect/Select the Evidence

An electronic literature search for articles published between January 1990 and September 2011 was conducted by using the PubMed, CINAHL, SCOPUS, and Cochrane Library databases.

### Number of Source Documents

The update of this clinical practice guideline is the result of reviewing a total of 124 articles: 3 randomized controlled trials, 103 prospective trials, 1 retrospective study, 3 case studies, 11 review articles, 2 surveys and 1 consensus paper on transcutaneous monitoring (TCM) for oxygen ( $P_{tcO_2}$ ) and carbon dioxide ( $P_{tcCO_2}$ ).

### Methods Used to Assess the Quality and Strength of the Evidence

Weighting According to a Rating Scheme (Scheme Given)

### Rating Scheme for the Strength of the Evidence

Grade of Quality of the Evidence

Grade	Quality	Description
A	High	Well-performed randomized controlled trials or overwhelming evidence of some other sort. Further research is very unlikely to change confidence in the estimate of the effect.
B	Moderate	Well-performed randomized controlled trials or overwhelming evidence of some other sort. Further research is very

Grade	Quality	Description
C	Low	Observational evidence (from observational studies, case series, or clinical experience), or evidence from controlled trials with serious flaws. Further research is very likely to have an important impact on confidence in the estimate of effect and is likely to change the estimate.
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## Methods Used to Analyze the Evidence

Systematic Review

## Description of the Methods Used to Analyze the Evidence

Not stated

## Methods Used to Formulate the Recommendations

Expert Consensus

## Description of Methods Used to Formulate the Recommendations

The recommendations are made following the Grading of Recommendations Assessment, Development and Evaluation (GRADE) criteria.

## Rating Scheme for the Strength of the Recommendations

Strength of the Recommendations

Level	Strength	Description
1	Stronger	Benefits clearly outweigh the risks and burdens (or vice versa) for nearly all patients.
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## Cost Analysis

A formal cost analysis was not performed and published cost analyses were not reviewed.

## Method of Guideline Validation

Not stated

## Description of Method of Guideline Validation



Not applicable

## Evidence Supporting the Recommendations

### Type of Evidence Supporting the Recommendations

The type of supporting evidence is identified and graded for selected recommendations (see the "Major Recommendations" field).

## Benefits/Harms of Implementing the Guideline Recommendations

### Potential Benefits

Appropriate utilization of transcutaneous monitoring of carbon dioxide and oxygen

### Potential Harms

$P_{tcO_2}$  and/or  $P_{tcCO_2}$  monitoring is considered a safe procedure. The most common hazards and complications of transcutaneous monitoring (TCM) are:

- Misinterpretation of falsely elevated or decreased levels of oxygen ( $O_2$ ) and carbon dioxide ( $CO_2$ ) that may lead to inappropriate treatment of the patient. Skin-surface partial pressure of oxygen ( $P_{tcO_2}$ ) underestimates arterial partial pressure of oxygen ( $P_{aO_2}$ ) and skin surface partial pressure of carbon dioxide ( $P_{tcCO_2}$ ) overestimates arterial partial pressure of carbon dioxide ( $P_{aCO_2}$ ). While some manufacturers have incorporated correction factors into the device software, what TCM really measures is skin  $PO_2$  and  $PCO_2$ , not  $P_{aO_2}$  and  $P_{aCO_2}$  per se.
- Thermal injury may occur at the sensor site (e.g., erythema, blisters, burns, skin tears).

## Contraindications

### Contraindications

There are no documented absolute contraindications for use of transcutaneous monitoring (TCM). In patients with poor skin integrity and/or adhesive allergy, alternative monitoring devices to TCM should be considered.

## Implementation of the Guideline

### Description of Implementation Strategy

An implementation strategy was not provided.

### Implementation Tools

Resources

For information about availability, see the *Availability of Companion Documents* and *Patient Resources* fields below.

# Institute of Medicine (IOM) National Healthcare Quality Report Categories

## IOM Care Need

Getting Better

Living with Illness

## IOM Domain

Effectiveness

Safety

## Identifying Information and Availability

### Bibliographic Source(s)

Restrepo RD, Hirst KR, Wittnebel L, Wettstein R. AARC clinical practice guideline: transcutaneous monitoring of carbon dioxide and oxygen: 2012. *Respir Care*. 2012 Nov;57(11):1955-62. [114 references] [PubMed](#)

### Adaptation

Not applicable: The guideline was not adapted from another source.

### Date Released

1994 Dec (revised 2012 Nov)

### Guideline Developer(s)

American Association for Respiratory Care - Professional Association

### Source(s) of Funding

American Association for Respiratory Care (AARC)

### Guideline Committee

American Association for Respiratory Care Clinical Practice Guidelines Steering Committee

### Composition of Group That Authored the Guideline

*Authors:* Ruben D Restrepo, MD RRT FAARC; Keith R Hirst, MSc RRT-NPS; Leonard Wittnebel, MSIS RRT; Richard Wettstein, MMed RRT

## Financial Disclosures/Conflicts of Interest

Dr. Restrepo has disclosed relationships with Oridion and Teleflex. The other authors have disclosed no conflicts of interest.

## Guideline Status

This is the current release of the guideline.

This guideline updates a previous version: American Association for Respiratory Care. Transcutaneous blood gas monitoring for neonatal & pediatric patients--2004 revision & update. Respir Care 2004 Sep;49(9):1069-72. [38 references]

## Guideline Availability

Electronic copies: Available in Portable Document Format (PDF) from the [American Association for Respiratory Care \(AARC\) Web site](#)

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Print copies: Available from the American Association for Respiratory Care (AARC), CPG Desk, 11030 Ables Ln, Dallas, TX 75229-4593;

Web site: [www.aarc.org](http://www.aarc.org) .

## Availability of Companion Documents

The following is available:

- Restrepo RD. American Association for Respiratory Care (AARC) clinical practice guidelines: from "reference-based" to "evidence-based." Respir Care. 2010 Jun;55(6):787-9. Available in Portable Document Format (PDF) from the [American Association for Respiratory Care \(AARC\) Web site](#) .

Print copies: Available from AARC, 9425 N. MacArthur Blvd., Ste. 100, Irving, TX 75063.

## Patient Resources

None available

## NGC Status

This summary was completed by ECRI on November 30, 1998. The information was verified by the guideline developer on December 15, 1998.

This NGC summary was updated by ECRI on March 21, 2005. This NGC summary was updated by ECRI on February 7, 2013.

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